

COLUMBIUM (NIOBIUM) AND TANTALUM

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Columbium (niobium-Nb) is vital as an alloying element in steels and in superalloys for aircraft turbine engines and is in greatest demand in industrialized countries. Columbium is critical to the United States because of its defense-related uses in the aerospace, energy, and transportation industries. Acceptable substitutes are available for some columbium applications, but in most cases they are less desirable.

Tantalum (Ta) is a refractory metal that is ductile, easily fabricated, has a high melting point, is highly resistant to corrosion by acids, and is a good conductor of heat and electricity. Tantalum is also critical to the United States because of its defense-related applications in aircraft, missiles, and radio communications. Substitution for tantalum is made at either a performance or economic penalty in most applications.

Domestic columbium and tantalum resources are of low grade. Some are mineralogically complex, and most are not currently commercially recoverable. The last significant mining of columbium and tantalum was during the Korean conflict when increased military demand resulted in columbium and tantalum ore shortages.

The United States continued to be dependent on imports of columbium and tantalum materials. Brazil continued as the major source for columbium imports, and Australia was the major source for tantalum imports. Columbium and tantalum price quotations were unchanged for the year. The Generalized System of Preferences (GSP), which expired on July 31, 1995, was extended to May 31, 1997. There was an overall increase in reported consumption of columbium in the form of ferrocolumbium and nickel columbium. Tantalum consumption was down for the year, owing to a drop in demand from the electronics industry.

Legislation and Government Programs

The high degree of import reliance for columbium and tantalum is a major concern of the United States. Summaries of important columbium and tantalum statistics are shown in tables 1 and 2, respectively. (*See tables 1 and 2.*)

To ensure a supply of columbium and tantalum during an emergency, goals for both materials have been established for the National Defense Stockpile (NDS). As of September 30, 1996, NDS overall goal for the columbium group was 982,000 kilograms, and the overall goal for the tantalum group was 1.05 million kilograms. (*See table 3.*)

In October, the interagency National Defense Stockpile

Market Impact Committee announced that it was seeking public comment on the potential market impact of the U.S. Department of Defense's (DOD) proposed disposals of materials from the NDS in the Federal Register. The Committee is comprised of representatives from the Departments of Commerce, State, Agriculture, Defense, Energy, Interior, Treasury, and the Federal Emergency Management Agency. The DOD proposed to dispose of about 27,200 kilograms of ferrocolumbium in fiscal year 1997 and about 45,400 kilograms in fiscal year 1998. Additionally, the DOD proposed to dispose of about 907 kilograms of tantalum carbide powder, about 45,400 kilograms of tantalum minerals, and about 9,070 kilograms of tantalum oxide in each of fiscal years 1997 and 1998. The deadline for comments to the Committee was November 1, 1996 (U.S. Department of Commerce, 1996). Subsequently, in December, the DOD presented a consolidated Annual Materials Plan for fiscal year 1997 stockpile disposals. The plan was said to be in response to requests from DOD customers. The maximum quantity of materials permitted for disposal under the plan included the 27,200 kilograms of ferrocolumbium, 907 kilograms of tantalum carbide powder, 45,400 kilograms of tantalum minerals, and 9,070 kilograms of tantalum oxide (Defense National Stockpile Center, 1996).

On August 20, 1996, the President signed the Small Business Job Protection Act of 1996, which contained provisions entitled the GSP Renewal Act of 1996. The Act provides that GSP duty free treatment will apply to eligible articles from designated beneficiary countries that are entered, or withdrawn from warehouse, for consumption on or after October 1, 1996, through May 31, 1997. Additionally, GSP duty free treatment will have certain retroactive applications to articles entered after July 31, 1995, and before October 1, 1996 (U.S. Department of the Treasury, 1996). Under GSP, the United States grants duty free access to goods from qualifying developing countries and territories. In 1996, U.S. imports for selected columbium and tantalum materials ranged from duty free to 5.1% ad valorem for most-favored-nation (MFN) status and from duty free to 45% ad valorem for non-MFN status.

Production

Domestic production data for ferrocolumbium are developed by the U.S. Geological Survey from the annual voluntary domestic survey for ferroalloys. However, ferrocolumbium production data for 1996 were incomplete at the time this report

was prepared.

There was no domestic mineral production of either columbium or tantalum in 1996. However, there were two processors of columbium- and tantalum-bearing source materials that were integrated from raw material processing to columbium and tantalum end products: Cabot Corp., Boyertown, PA, for columbium and tantalum processing, and Shieldalloy Metallurgical Corp., Newfield, NJ, dedicated solely to columbium processing. H.C. Starck GmbH & Co. KG, with plants in Newton, MA, and Gurnee, IL, was a major supplier of tantalum and columbium products. Reading Alloys Inc., Robesonia, PA, and Wah Chang, a subsidiary of Allegheny Teledyne Inc., Albany, OR, were major producers of high-purity columbium products. Kennametal Inc., Latrobe, PA, was a major supplier of columbium and tantalum carbides.

Vishay Intertechnology Inc., Malvern, PA, announced that the company had formed a partnership with the Eisenberg Group of Companies. The new partnership reportedly signed a cooperation agreement with the China National Non-Ferrous Metals Industry Corp., a Chinese Government agency. The agreement provides for the comprehensive development of the tantalum industry in China including the mining and refining of tantalum ore and the production of tantalum capacitors in China through several joint ventures. Additionally, Vishay, the largest U.S. producer of passive electronic components, including capacitors, was pursuing the acquisition of Kemet Corp., Greenville, SC, the largest U.S. manufacturer of tantalum capacitors (American Metal Market, 1996a; Ryan's Notes, 1996; Tantalum-Niobium International Study Center, 1996).

According to its annual report, Kennametal Inc., Latrobe, PA, reported that the company's board of directors approved a plan in January to build a \$20 million facility in Shanghai, China. The facility will be used to manufacture cemented carbide metalcutting tools (Kennametal Inc., 1996).

On August 15, Allegheny Ludlum Corp., Pittsburgh, PA, and Teledyne, Inc., Los Angeles, CA, combined to form Allegheny Teledyne Inc., headquartered in Pittsburgh, PA. Allegheny Ludlum shareholders received one share of Allegheny Teledyne common stock for each of their Allegheny Ludlum common shares, while Teledyne stockholders received 1.925 shares of Allegheny Teledyne common stock for each of their Teledyne common shares. Allegheny Teledyne, a group of technology-based manufacturing businesses, will serve worldwide customers with specialty metals for consumer, industrial and aerospace applications; and commercial and government-related aerospace and electronics products. Allegheny Teledyne's Wah Chang division, Albany, OR, is a leading producer of reactive and refractory metals, including columbium and its alloys (Allegheny Teledyne Inc., 1996).

Consumption

Overall reported consumption of columbium as ferrocolumbium and nickel columbium increased by about 4%. (See table 4.) Consumption of columbium by the steelmaking industry increased by about 5%, with the percentage of

columbium usage per ton of steel produced up by about 4%. Columbium consumption was up or relatively unchanged in all major reported steel end-use categories. Demand for columbium in superalloys increased to about 509,000 kilograms. That portion used in the form of nickel columbium rose to about 350,000 kilograms.

Overall consumption of tantalum was down from that of 1995. Industry sources indicated that factory sales of tantalum capacitors decreased by about 15%, the first decline in sales since 1989. A weaker demand for personal computers and some telecommunications equipment, such as portable telephones and the liquidation of inventories accumulated in 1995 influenced the drop in sales.

Columbium.—Columbium and niobium are synonymous names for the chemical element with atomic number 41; columbium was the first name given, and niobium was the name officially designated by the International Union of Pure and Applied Chemistry in 1950. The metal conducts heat and electricity relatively well, has a high melting point (about 2,470 °C), is readily fabricated, and is highly resistant to many chemical environments.

Columbium, in the form of ferrocolumbium, is used worldwide, principally as an additive to improve the strength and corrosion resistance of steel. Because of its refractory nature, appreciable amounts of columbium in the form of high-purity ferrocolumbium and nickel columbium are used in nickel-, cobalt-, and iron-base superalloys for applications such as jet engine components, rocket subassemblies, and heat-resisting and combustion equipment. Columbium carbide is used in cemented carbides to modify the properties of the cobalt-bonded tungsten carbide-based material. It is usually used with carbides of metals such as tantalum and titanium. Columbium oxide is the intermediate product used in the manufacture of high-purity ferrocolumbium, nickel columbium, columbium metal, and columbium carbide.

Tantalum.—The major end use for tantalum, as tantalum metal powder, is in the production of electronic components, mainly tantalum capacitors. Applications for tantalum capacitors include computers, communication systems, instruments and controls for aircraft, missiles, ships, and weapon systems. The tantalum capacitor exhibits reliable performance and combines compactness and high efficiency with good shelf-life. Because of its high melting point (about 3,000 °C), good strength at elevated temperatures and good corrosion resistance, tantalum is combined with cobalt, iron, and nickel to produce superalloys that are employed in aerospace structures and jet engine components. Tantalum carbide, used mostly in mixtures with carbides of such metals as columbium, titanium, and tungsten, is used in cemented-carbide cutting tools, wear-resistant parts, farm tools, and turning and boring tools. Because of tantalum's excellent corrosion-resistant properties, tantalum mill and fabricated products are used in the chemical industry in applications such as heat exchangers, evaporators, condensers, pumps, and liners for reactors and tanks.

Prices

A published price for pyrochlore concentrates was not available. A price for Brazilian pyrochlore has not been available since 1981 when exports were stopped, and the published price for pyrochlore produced in Canada was suspended in early 1989. The Platt's Metals Week price for regular-grade ferrocolumbium, produced from pyrochlore concentrates, was unchanged throughout the year at \$6.58 per pound of contained columbium.

The Metal Bulletin price for columbite ore, on the basis of a minimum 65% contained Nb_2O_5 and Ta_2O_5 , remained unchanged at a range of \$2.80 to \$3.20 per pound. For the year, the Metals Week price for columbium oxide was \$8.17 per pound of oxide; the price for high-purity ferrocolumbium containing 62% to 68% columbium was \$18.50 per pound of contained columbium, f.o.b. shipping point; the price for nickel columbium was \$20.50 per pound of contained columbium; and the price for columbium metal was at a range of \$30 to \$50.

The Metals Week spot price for tantalite ore, on the basis of contained Ta_2O_5 , f.o.b. U.S. ports, remained unchanged at a range of \$27 to \$28.50 per pound. For the year, the Metal Bulletin price for tantalite was at a range of \$28 to \$31.50 per pound of contained Ta_2O_5 . The Metal Bulletin price for tantalite produced at the Greenbushes Mine in Australia, on the basis of 40% contained Ta_2O_5 , was \$40 per pound. Industry sources indicated that the average selling prices for some tantalum products were as follows (per pound of contained tantalum): powder, \$100 to \$180; wire, \$170 to \$250; and sheet, \$100 to \$150. Tantalum oxide was selling at an average of \$40 to \$90 per pound of oxide, and the average selling price for tantalum carbide was \$45 to \$60 per pound.

Foreign Trade

Data for exports and imports are summarized in table 5. Net trade for columbium and tantalum continued at a deficit. Overall trade value for exports was up by about 16%, with total volume down by more than 20%. For imports, overall trade value was down slightly with total volume down by more than 20%. (See table 5.)

Imports for consumption of columbium ores and concentrates were down, owing to the continued decrease in the volume of imports from Canada. (See table 6.) Imports at an average grade of approximately 47% Nb_2O_5 and 17% Ta_2O_5 were estimated to contain about 75,000 kilograms of columbium and about 25,000 kilograms of tantalum.

Imports for consumption of tantalum ores and concentrates increased by more than 10%, with imports from Australia accounting for more than 50% of total quantity and total value. (See table 7.) Imports at an average grade of approximately 40% Ta_2O_5 and 26% Nb_2O_5 were estimated to contain about 335,000 kilograms of tantalum and about 210,000 kilograms of columbium.

Imports for consumption of synthetic tantalum-columbium concentrates totaled 30,000 kilograms valued at \$1.1 million

compared with 100,000 kilograms valued at \$872,000 in 1995. These figures are not included in the salient statistics data.

The schedule of tariffs applied during 1996 to U.S. imports of selected columbium and tantalum materials is found in the U.S. International Trade Commission's (USITC's) 1996 Harmonized Tariff Schedule of the United States, USITC Publication 2937. Brazil remained the major source for U.S. columbium imports, accounting for more than 60% of the total, and Australia was the major source for U.S. tantalum imports, accounting for more than 30% of the total. (See figures 1 and 2.)

World Review

Industry Structure.—Principal world columbium and tantalum raw material and product producers are shown in tables 8 and 9, respectively. Brazil and Canada remained the major producers of columbium mineral concentrates, while tantalum mineral concentrates continued to be produced mainly in Australia, Brazil, and Canada. Annual world production of columbium and tantalum mineral concentrates, by country, is given in table 10. (See tables 8, 9, and 10.)

Australia.—For its fiscal year ending June 30, 1996, Gwalia Consolidated Ltd., the world's largest producer of tantalum concentrates, reported that tantalum oxide produced in tantalum concentrates at its Greenbushes Mine, southwest Western Australia, was about 272 tons, a record level, compared with about 211 tons in 1995. Mill ore throughput increased by 20% with higher recoveries to final product. Sales of tantalum oxide in concentrate produced at the Greenbushes operation increased to a record 251 tons. During the 3 months ending June 30, 1996, Gwalia finalized purchase of the Wodgina Tantalum Mine and surrounding tenements for a reported \$14.5 million. Wodgina is 100 kilometers inland from Port Hedland, northwest Western Australia. Mining of ore at the Mount Cassiterite open pit operation is performed by contractors on a 3-month campaign basis per year. Tantalum concentrate produced at Wodgina is shipped to the Greenbushes operation for upgrading. Gwalia reported that the company had renegotiated and extended sales contracts for all tantalum production at Greenbushes and Wodgina to the year 2000. Sale of the concentrate over the 4-year period will secure the company revenue of \$180 million (Gwalia Consolidated Ltd., 1996).

Brazil.—Brazil's production of columbium oxide in concentrates decreased to about 19,300 tons — 15,700 tons produced by Cia. Brasileira de Metalurgia e Mineracao (CBMM) and 3,600 tons produced by Mineracao Catalao de Goias S.A. CBMM, the world's largest columbium producer, was reported to have the capacity to produce 24,000 tons of steelmaking-grade ferrocolumbium, 600 tons of high-purity ferrocolumbium, 600 tons of nickel columbium, and 2,000 tons of high-purity columbium oxide. Brazil's consumption of columbium, based on contained columbium oxide, totaled 930 tons, compared with 1,020 tons in 1995 (The TEX Report, 1997).

In January, CBMM announced that the company would increase the price for ferrocolumbium and columbium oxide, the first price increase by CBMM since July 1989. The price increase was effective January 1, owing to the rising costs of reduction agents such as aluminum, increased labor costs, a 4.5% tax on columbium exports, and capital investments to improve production processes (Metal Bulletin, 1996a).

Canada.—Teck Corp. reported that production of columbium oxide contained in concentrate at the Niobec Mine near Chicoutimi, Quebec, decreased to about 3.32 million kilograms. Niobec is a 50-50 joint venture between Teck, operator, and Cambior Inc., product marketing. Ore milled increased to 810,000 tons, as the mill operated on the average of 2,220 tons of ore per day. Average recovery was 58.8% with Nb₂O₅ grade of concentrate at 70%. Teck reported that Niobec ore reserves are sufficient for another 15 years of mine life. In 1997, Niobec is forecast to produce about 2.18 million kilograms of columbium, with capital expenditures projected at \$4.5 million. The expenditures will include \$3 million for the first phase development of a lower ore block (increasing hoist system capacity and establishing ventilation and shaft access). This development along with a second phase to deepen the shaft, to be completed by mid-1999, is expected to add 4 million tons to mine ore reserves (Teck Corp., 1996).

Since midyear 1992, tantalum mining at the Bernic Lake, Manitoba, tantalum operation has remained suspended. However, about 59 tons of tantalum oxide contained in concentrate was produced from tailings retreatment in 1996.

Germany.—H.C. Starck GmbH & Co. KG, Goslar, a wholly owned subsidiary of Bayer AG, Leverkusen, acquired a majority holding in Thai Tantalum Co. Ltd., Map Ta Phut, Thailand, a tantalum source material processing plant that produces potassium fluotantalate and tantalum metal powder. The acquisition improves Starck's access to raw materials and markets for the company's products in Southeast Asia (American Metal Market, 1996b; Metal Bulletin, 1996c). The acquisition also included a tantalum capacitor-grade powder facility in Gurnee, IL.

Japan.—Japan's production of ferrocolumbium was idle compared with 39 tons produced in 1995. Domestic consumption of ferrocolumbium totaled about 4,620 tons compared with about 4,430 tons in 1995. Ferrocolumbium imports totaled about 4,760 tons (The TEX Report, 1997).

Japan's demand for tantalum, in the form of powder, compounds, and tantalum products, was about 322 tons compared with about 315 tons in 1995. Japanese imports of these products in 1996 totaled about 108 tons. Japan's production of tantalum capacitors was about 5.5 billion units compared with about 5.8 billion units in 1995. Japan's shipments of tantalum capacitors in 1996 totaled about 5.4 billion units (Roskill's Letter from Japan, 1997).

Mozambique.—Cabot Corp., Boston, MA, in a venture with Madal S.A.R.L. and Lydenburg Exploration, South Africa, was conducting a feasibility study on reopening the Morrua tantalum property in Mozambique, 340 kilometers from Quelimane. Completion of the study is expected in early 1997. Morrua was

a major tantalum producing property during the period from the late 1950's to the early 1980's (Tantalum-Niobium International Study Center, 1996).

Russia.—Metallurg Inc., New York, NY, a supplier of speciality alloys and metals, announced in August that the company had acquired an undisclosed share holding in Solikamsk Magnesium Works, which is in the Perm region of Russia. Solikamsk produces magnesium products, rare earth compounds, titanium oxide, and the company produces about 55 to 60 tons of tantalum oxide and 700 to 750 tons of columbium oxide per year. The holding reportedly gives Metallurg better access to Solikamsk's products for either consumption within Metallurg's group of companies or for distribution elsewhere (Metal Bulletin, 1996b).

Outlook

Columbium.—The principal use for columbium remains as an additive in steelmaking, which annually accounts for more than 80% of reported consumption in the United States. The trend of columbium demand, domestically and globally, will continue to follow closely that of steel production. The reader is referred to the outlook section of the Iron and Steel Annual Mineral Industry Surveys for discussion on the outlook for the steel industry. Industry sources indicate that the annual growth rate for world steel consumption through the year 2000 will be almost 2%. Most growth will occur in China, other Asian countries, with the exception of Japan, and in Latin America. Asia was projected to account for 47% of world steel consumption by the year 2000 (Iron & Steelmaker, 1996).

Tantalum.—In 1996, U.S. apparent consumption of tantalum totaled about 490,000 kilograms compared with about 515,000 kilograms in 1995. For the past decade, more than 60% of the tantalum consumed has been used to produce electronic components, mainly tantalum capacitors. Industry sources indicate that worldwide consumption of tantalum capacitors is expected to increase to about 25 billion units by the year 2000, a 14% annual growth rate. During this period, the annual per-unit requirement of tantalum powder and wire for tantalum capacitors is expected to decline at an annual rate of 6% and 5%, respectively. However, the overall trend is for increased tantalum consumption. Thus, world consumption in this sector is expected to be about 953,000 kilograms of tantalum by the year 2000. Tantalum demand in the cemented carbide sector will continue to be limited by the use of coatings, which prolong tool life, and by efforts to achieve near-to-shape form through powder metallurgy to minimize subsequent machining. Growth in this sector is expected to be less than 5% annually.

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¹Prior to January 1996, published by the U.S. Bureau of Mines.

TABLE 1
SALIENT COLUMBIUM STATISTICS 1/

(Thousand kilograms of columbium content unless otherwise specified)

	1992	1993	1994	1995	1996
United States:					
Mine production of columbium-tantalum concentrates	(2/)	--	--	--	--
Releases from Government excesses	--	--	--	--	--
Production of ferrocolumbium	NA	NA	NA	NA	NA
Exports: Columbium metal, compounds, alloys (gross weight)	NA	NA	NA	NA	NA
Imports for consumption:					
Mineral concentrates e/	1,230	1,210	1,480	615	285
Columbium metal and columbium-bearing alloys e/	1	111	171	257	322
Ferrocolumbium e/	2,450	2,190	2,590	3,580	2,970
Tin slag	NA	NA	NA	NA	NA
Consumption:					
Raw materials	NA	NA	NA	NA	NA
Ferrocolumbium and nickel columbium e/	2,460	2,470	2,750	2,900	3,020
Apparent e/	3,500	3,500	3,700	3,800	3,800
Prices:					
Columbite, dollars per pound 3/	2.83	2.67	2.60	2.97	3.00
Pyrochlore, dollars per pound 4/	2.75	2.75	NA	NA	NA
World: Production of columbium-tantalum concentrates e/	15,300	12,400	15,400	18,000 r/	16,000

e/ Estimated. r/ Revised. NA Not available.

1/ Data are rounded to three significant digits, except prices.

2/ A small unreported quantity was produced.

3/ Average value, contained pentoxides for material having a columbium pentoxide to tantalum pentoxide ratio of 10 to 1.

4/ Average value, contained pentoxide.

TABLE 2
SALIENT TANTALUM STATISTICS

(Thousand kilograms of tantalum content unless otherwise specified)

	1992	1993	1994	1995	1996
United States:					
Mine production of columbium-tantalum concentrates	(1/)	(1/)	--	--	--
Releases from Government excesses	--	--	--	--	--
Exports:					
Tantalum ores and concentrates (gross weight) 2/	17	11	23	1	53
Tantalum metal, compounds, alloys (gross weight)	136	235	242	281	342
Tantalum and tantalum alloy powder (gross weight)	61	57	46	41	26
Imports for consumption:					
Mineral concentrates e/	420	390	310	300	360
Tantalum metal and tantalum-bearing alloys 3/	14	67	73	181	203
Tin slag	NA	NA	NA	NA	NA
Consumption:					
Raw materials	NA	NA	NA	NA	NA
Apparent e/	375	410	430	515	490
Prices:					
Tantalite, dollars per pound 4/	28.19	26.41	26.24	26.98	27.75
World: Production of columbium-tantalum concentrates e/	399	310	333	362 r/	383

e/ Estimated. r/ Revised. NA Not available.

1/ A small unreported quantity was produced.

2/ Includes reexports.

3/ Exclusive of waste and scrap.

4/ Average value, contained tantalum pentoxides.

TABLE 3
COLUMBIUM AND TANTALUM MATERIALS IN GOVERNMENT
INVENTORIES AS OF DECEMBER 31, 1996 1/

(Thousand kilograms of columbium or tantalum content)

Material	Stockpile goals	Disposal authority	National Defense Stockpile inventory			Committed
			Stockpile-grade	Nonstockpile-grade	Total	
Columbium:						
Concentrates	--	--	444	343	786	--
Carbide powder	--	--	10	--	10	--
Ferrocolumbium		422	385	151	535	--
Metal ingots	--	--	73	--	73	--
Total	982 3/	422	911	493	1,400	--
Tantalum:						
Minerals	--	340	681	454	1,140	--
Carbide powder	--	--	13	--	13	--
Metal:						
Capacitor grade	--	--	73	(4/)	73	--
Ingots	--	--	46	--	46	--
Oxide	--	18	74	--	74	--
Total	1,050 3/	358	887	454	1,340	--

1/ Data are rounded to three significant digits; may not add to totals shown.

2/ The stockpile also contained an uncommitted inventory of 65,000 kilograms in tantalum metal ingots with status (inventory) not yet determined.

3/ Overall goals for the columbium and tantalum groups as of Sept. 30, 1996.

4/ 45 kilograms.

Source: Defense Logistics Agency, Defense National Stockpile Center.

TABLE 4
REPORTED CONSUMPTION, BY END USE, AND INDUSTRY STOCKS OF
FERROCOLUMBIUM AND NICKEL COLUMBIUM
IN THE UNITED STATES 1/

(Kilograms of contained columbium 2/)

End use	1995	1996
Steel:		
Carbon	917,000	1,030,000
Stainless and heat-resisting	408,000	413,000
Full alloy	(3/)	(3/)
High-strength low-alloy	1,050,000	1,050,000
Electric	--	--
Tool	(4/)	(4/)
Unspecified	5,060	6,880
Total	2,380,000	2,500,000
Superalloys	506,000	509,000
Alloys (excluding alloy steels and superalloys)	(5/)	(5/)
Miscellaneous and unspecified	9,820	7,110
Total	2,900,000	3,020,000
Stocks, Dec. 31:		
Consumer	NA	NA
Producer 6/	NA	NA
Total	NA	NA

NA Not available.

1/ Data are rounded to three significant digits; may not add to totals shown.

2/ Includes columbium and tantalum in ferrotantalum-columbium, if any.

3/ Included with "Steel: High-strength low alloy."

4/ Included with "Steel: Unspecified."

5/ Included with "Miscellaneous and unspecified."

6/ Ferrocolumbium only.

TABLE 5
U.S. FOREIGN TRADE IN COLUMBIUM AND TANTALUM METAL AND ALLOYS, BY CLASS 1/

(Thousand kilograms, gross weight, and thousand dollars)

Class	1995		1996		Principal destinations and sources, 1996
	Quantity	Value	Quantity	Value	
Exports: 2/					
Columbium:					
Ores and concentrates	96	869	11	185	United Kingdom 2, \$65; Japan 1, \$49; Korea, Republic of 2, \$44; Hong Kong 4, \$14; Brazil 2, \$13.
Ferrocolumbium	529	4,450	254	1,490	Netherlands 133, \$550; Korea, Republic of 50, \$350; Mexico 27, \$265; Australia 16, \$147; Venezuela 12, \$119; Brazil 14, \$43.
Tantalum:					
Synthetic concentrates	1	19	38	192	United Kingdom 34, \$68; Taiwan 1, \$66; Japan 1, \$35; Philippines 2, \$16; Austria 1, \$7.
Ores and concentrates	1	36	53	572	Israel 8, \$178; Brazil 19, \$148; China 13, \$91; Hong Kong 3, \$90; Russia 9, \$58.
Unwrought and waste and scrap	143	5,990	152	7,420	Germany 54, \$3,900; China 85, \$1,810; United Kingdom 7, \$1,070; Japan 3, \$395; Netherlands 2, \$143; Kazakstan, 1, \$96.
Unwrought powders	41	11,000	26	7,860	Japan 8, \$2,510; Germany 7, \$2,380; France 6, \$1,640; United Kingdom 4, \$1,180; Taiwan (3/), \$65; Portugal (3/), \$29.
Unwrought alloys and metal	27	8,790	91	24,900	Israel 53, \$12,000; United Kingdom 15, \$6,190; France 13, \$3,420; Taiwan 3, \$1,070; Barbados 2, \$826; Austria 2, \$487.
Wrought	111	33,000	99	32,100	Japan 34, \$15,300; Germany 21, \$5,850; United Kingdom 8, \$2,980; France 6, 2,790; Canada 22, \$2,250; Sweden 1, \$522.
Total	XX	64,200	XX	74,700	Japan \$18,300; Germany \$12,500; Israel \$12,400; United Kingdom \$11,600;
Imports for consumption:					
Columbium:					
Ores and concentrates	1,040	6,580	224	1,700	Russia 92, \$921; Nigeria 93, \$513; Canada 38, \$201; United Kingdom (3/), \$19; China 1, \$14; Italy (3/), \$14.
Oxide	1,320	20,200	901	16,300	Brazil 566, \$9,030; Germany 144, \$5,270; Russia 156, \$1,540; Finland 20, \$197; Thailand 10, \$154; China 4, \$108.
Ferrocolumbium	5,510	45,000	4,570	42,100	Brazil 3,360, \$29,300; Canada 1,160, \$12,000; Germany 28, \$583; France 27, \$249; Japan (3/), \$11.
Unwrought alloys, metal, and powder	257	5,380	322	8,310	Germany 170, \$3,570; Brazil 58, \$1,590; Kazakstan 46, \$1,520; Russia 40, \$1,350; Estonia 7, \$261; United Kingdom 1, \$8.
Tantalum:					
Synthetic concentrates	100	872	30	1,090	China 30, \$1,080; Germany (3/), \$14.
Ores and concentrates	1,020	23,400	1,130	26,400	Australia 593, \$14,900; Ethiopia 70, \$2,910; Brazil 134, \$2,280; Rwanda 71, \$1,260; Burundi 60, \$1,190; Thailand 60, \$997; Russia 79, \$872; China 23, \$735.
Unwrought waste and scrap	364	28,500	279	22,500	Japan 69, \$6,870; Kazakstan 29, \$3,810; Lithuania 25, \$2,500; Germany 43, \$2,440; United Kingdom 19, \$1,600; Russia 11, \$1,070; France 10, \$911; China 9, \$902.
Unwrought powders	101	21,600	125	30,000	Thailand 55, \$11,800; Japan 27, \$8,770; China 26, \$6,270; France 6, \$1,930; Russia 5, \$573; Kazakstan 3, \$398.
Unwrought alloys and metal	75	9,590	67	11,000	Kazakstan 26, \$3,890; Germany 21, \$2,990; France 10, \$1,790; China 4, \$1,160; Israel 3, \$630; Japan 1, \$386; United Kingdom 1, \$122.
Wrought	5	1,500	11	2,820	China 8, \$1,550; Austria 1, \$352; United Kingdom (3/), \$285; Japan (3/), \$189; Germany 1, \$180; Switzerland (3/), \$131; Russia 1, \$69.
Total	XX	162,000	XX	162,000	Brazil \$42,200; Japan \$16,200; Germany \$15,300; Australia \$14,900; Thailand \$13,700; Canada \$12,200; China \$11,800.

XX Not applicable.

1/ Data are rounded to three significant digits; may not add to totals shown.

2/ For columbium, data on exports of metal and alloys in unwrought and wrought form, including waste and scrap, are not available; included in nonspecific tariff classification.

3/ Less than 1/2 unit.

Sources: Bureau of the Census and U.S. Geological Survey.

TABLE 6
U.S. IMPORTS FOR CONSUMPTION OF COLUMBIUM ORES AND CONCENTRATES, BY COUNTRY 1/

(Thousand kilograms and thousand dollars)

Country	1995		1996	
	Gross weight	Value	Gross weight	Value
Brazil	27	130	--	--
Canada	851	5,400	38	201
China	--	--	1	14
Estonia	1	53	--	--
Germany 2/	(3/)	13	(3/)	13
Italy 2/	--	--	(3/)	14
Japan 2/	--	--	(3/)	2
Nigeria	117	618	93	513
Russia	41	355	92	921
United Kingdom 2/	2	10	(3/)	19
Total	1,040	6,580	224	1,700

1/ Data are rounded to three significant digits; may not add to totals shown.

2/ Presumably country of transshipment rather than original source.

3/ Less than 1/2 unit.

Sources: Bureau of the Census and U.S. Geological Survey.

TABLE 7
U.S. IMPORTS FOR CONSUMPTION OF TANTALUM ORES AND CONCENTRATES, BY COUNTRY 1/

(Thousand kilograms and thousand dollars)

Country	1995		1996	
	Gross weight	Value	Gross weight	Value
Australia	323	10,700	593	14,900
Belgium 2/	20	403	2	106
Brazil	170	3,390	134	2,280
Burundi	123	2,260	60	1,190
China	69	1,270	23	735
Ethiopia	7	263	70	2,910
Germany 2/	22	423	1	3
Japan 2/	(3/)	12	(3/)	7
Kazakstan	18	174	--	--
Malaysia	10	154	--	--
Nigeria	40	1,510	19	699
Russia	--	--	79	872
Rwanda	31	598	71	1,260
South Africa	1	37	--	--
Spain	25	459	3	77
Sri Lanka	--	--	4	90
Thailand	127	988	60	997
Zaire	32	677	13	305
Total	1,020	23,400	1,130	26,400

1/ Data are rounded to three significant digits; may not add totals shown.

2/ Presumably country of transshipment rather than original source.

3/ Less than 1/2 unit.

Sources: Bureau of the Census and U.S. Geological Survey.

TABLE 8
PRINCIPAL WORLD COLUMBIUM AND TANTALUM RAW MATERIAL PRODUCERS

Country	Company and/or mine	Material type
Mining of columbium- and tantalum-bearing ores:		
Australia	Gwalia Consolidated Ltd. (Greenbushes)	Columbium-tantalum.
	Gwalia Consolidated Ltd. (Wodgina)	Tantalum.
Brazil	Cia. Brasileira de Metalurgia e Mineracao (CBMM) (Araxa)	Columbium.
	Cia. de Estanho Minas Brasil (MIBRA) 1/	Columbium-tantalum.
	Parapanema S.A. Mineracao Indústria e Construcao (Pitinga)	Columbium-tantalum.
	Mineracao Catalao de Goias S.A. (Catalao)	Columbium.
Canada	Cambior/Teck Corp. (Niobec)	Columbium.
	Tantalum Mining Corp. of Canada Ltd. (Tanco) 2/	Tantalum.
China	Government-owned	Columbium-tantalum.
Production of columbium- and tantalum-bearing tin slags:		
Australia	Gwalia Consolidated Ltd. (Greenbushes).	
Brazil	Cia. Industrial Fluminense. 1/ Mamoré Mineracao e Metalurgia. 3/	
Thailand	Thailand Smelting and Refining Co. Ltd. (Thaisarco).	
Production of columbium- and tantalum-bearing synthetic concentrates:		
Germany: Western states	Gesellschaft Für Elektrometallurgie mbH (GFE). 1/ H.C. Starck GmbH & Co. KG.	

1/ A wholly owned subsidiary of Metallurg Inc., New York, NY.

2/ A wholly owned subsidiary of Cabot Corp.

3/ A subsidiary of Parapanema S.A. Mineracao Indústria e Construcao.

TABLE 9
PRINCIPAL WORLD PRODUCERS OF COLUMBIUM AND TANTALUM PRODUCTS

Country		Products 1/
Austria	Treibacher Chemische Werke AG	Nb and Ta oxide/carbide, FeNb, NiNb.
Brazil	Cia. Brasileira de Metalurgia e Mineracao (CBMM) Cia. Industrial Fluminense 2/ Mineracao Catalao de Goias S.A. (Catalao)	Nb oxide/metal, FeNb, NiNb. Nb and Ta oxide. FeNb.
Estonia	Silmet	Nb oxide/metal.
Germany: Western states	Gesellschaft Fur Elektrometallurgie mbH (GFE) 2/ H.C. Starck GmbH & Co. KG	FeNb, NiNb. Nb and Ta oxide/metal/carbide, K-salt, FeNb, NiNb, Ta capacitor powder.
Japan	Mitsui Mining & Smelting Co. Showa Cabot Supermetals 3/ H.C. Starck-V Tech Ltd. 4/	Nb and Ta oxide/metal/carbide. Ta capacitor powder. Ta capacitor powder.
Kazakstan	Ulba Metallurgical Irtys Chemical & Metallurgical Works	Ta oxide/metal. Nb oxide/metal.
Russia	Solikamsk Magnesium Works	Nb and Ta oxide.
Thailand	H.C. Starck (Thailand) Co. Ltd. 4/	K-salt, Ta metal.
United States	Cabot Corp. H.C. Starck Inc. 5/ Kennametal, Inc. Reading Alloys, Inc. Shieldalloy Metallurgical Corp. 2/ Wah Chang 6/ H.C. Starck - TTI, Inc. 4/	Nb and Ta oxide/metal, K-Salt, FeNb, NiNb, Ta capacitor powder. Nb and Ta metal, Ta capacitor powder. Nb and Ta carbide. FeNb, NiNb. FeNb, NiNb. Nb oxide/metal, FeNb, NiNb. Ta capacitor powder.

1/ Nb, columbium; Ta, tantalum; FeNb, ferrocolumbium; NiNb, nickel columbium; K-salt, potassium fluotantalate; oxide, pentoxide.

2/ A wholly owned subsidiary of Metallurg Inc., New York.

3/ A joint venture between Showa Denko and Cabot Corp.

4/ A subsidiary of H.C. Starck GmbH & Co. KG.

5/ Jointly owned by Bayer USA and H.C. Starck GmbH & Co. KG.

6/ A subsidiary of Allegheny Teledyne Inc.

TABLE 10
COLUMBIUM AND TANTALUM: ESTIMATED WORLD PRODUCTION OF MINERAL CONCENTRATES, BY COUNTRY 1/ 2/

(Thousand kilograms)

Country 5/	Gross weight 3/					Columbium content 4/					Tantalum content 4/				
	1992	1993	1994	1995	1996	1992	1993	1994	1995	1996	1992	1993	1994	1995	1996
Australia: Columbite-tantalite	656	495	700	900	920	69	50	81	109	112	224	170	238	274	276
Brazil:															
Columbite-tantalite	200	175	175	175	190	45	40	40	40	45	60	50	50	50	55
Pyrochlore	29,600	22,700	30,700	36,900 r/	32,100	12,500	9,540	12,900	15,500 r/	13,500	--	--	--	--	--
Canada:															
Pyrochlore	5,100	5,320	5,130	5,230	5,160	2,300	2,390	2,310	2,350	2,320	--	--	--	--	--
Tantalite	200	100	144	130 r/	190	8	5	7	7 r/	10	48	25	36	33 r/	48
Namibia: Tantalite	-- r/	--	--	(6/)	--	-- r/	--	--	NA	--	-- r/	--	--	(6/)	--
Nigeria: Columbite	40	40	30	30	25	17	17	13	13	10	2	2	2	2	2
Rwanda: Columbite-tantalite	100	100	10	--	--	30	30	3	--	--	22	22	2	--	--
South Africa: Columbite-tantalite	(6/)	(6/)	--	--	--	(6/)	(6/)	--	--	--	(6/)	(6/)	--	--	--
Spain: Tantalite	8	6	6	-- r/	--	NA	NA	NA	-- r/	--	2	2	2	-- r/	--
Zaire:															
Columbite-tantalite	29	20	4	4	--	8	5	1	1	--	8	6	1	1	--
Pyrochlore	780	780	--	--	--	350	350	--	--	--	--	--	--	--	--
Zimbabwe: Columbite-tantalite	94	94	7	7	7	14	14	1	1	1	33	33	2	2	2
Total	36,800	29,800	36,900	43,400 r/	38,600	15,300	12,400	15,400	18,000 r/	16,000	399	310	333	362 r/	383

r/ Revised. NA Not available.

1/ Data are rounded to three significant digits; may not add to totals shown.

2/ Excludes columbium- and tantalum-bearing tin ores and slags. Production of tantalum contained in tin slags was, in thousand kilograms: 1992--160; 1993--132; 1994--NA; 1995--126; and 1996--82 according to data from the Tantalum-Niobium International Study Center. Table includes data available through July 10, 1997.

3/ Data on gross weight generally have been presented as reported in official sources of the respective countries, divided into concentrates of columbite, tantalite, and pyrochlore where information is available to do so, and reported in groups such as columbite and tantalite where it is not.

4/ Unless otherwise specified, data presented for metal content are estimates based on, in most part, reported gross weight and/or pentoxide content.

5/ In addition to the countries listed, Bolivia, China, Russia, and Zambia also produce, or are believed to produce, columbium and tantalum mineral concentrates, but available information is inadequate to make reliable estimates of output levels.

6/ Less than 1/2 unit.